SCIENCE EDUCATION

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Institutions will be expected to demonstrate the use of performance assessments within their programs. Examples of such assessments are provided by the Education Standards and Practices Board with the standards as guidelines. Institutions are not restricted to using the examples listed, but may develop others that assess candidates knowledge and skills base and demonstrate candidates' ability to apply what they have learned in the P-12 school setting.

It is expected that institutions will be looking at candidates' knowledge and abilities from a variety of perspectives. The types of assessment used could include knowledge-base tests, demonstrations of teaching skill, observations by faculty and cooperating school personnel, portfolios, group projects, problem-solving activities, laboratory demonstrations, exhibits or performances, candidate writings or journals, or candidate self-assessment reflections, and evaluations of practicum and field based experiences.

A portion of the assessments must be conducted in authentic settings and consider the candidate's potential to positively impact student learning. Course syllabi should clearly identify the types of performance assessments expected.

The program to prepare teachers of science usually follows one of two patterns: (1) the subject major pattern emphasizing one or more areas of the sciences with supporting coursework in other sciences, (minimum of 48 semester hours), or (2) the comprehensive major pattern which is a balanced study across the science areas. Programs must meet the appropriate section of Standard 1 (biology or chemistry or earth science or composite/general science or physical science or physics) and also Standards 2 through 10 which apply to all majors.

Highly qualified teachers in science: Secondary teachers with majors in biology,

chemistry, earth science or physics (minimum of 32 SH) or physical science and other composite science degrees (minimum of 42 SH) will be licensed to teach in each specific science discipline in which the individual has the *minimum* preparation for that specific science discipline aligned with the ND standards for the areas (12 SH).

13010.1 BIOLOGY

The biology program requires study of zoology, botany, anatomy/morphology, physiology, genetics, ecology/environment, microbiology, cell biology/biochemistry, and evolution. This study includes:

1. laboratory and field experiences using a variety of living materials and instrumentation;
2. identification of biological phenomena;
3. characteristics of living organisms and their relationship with their physical and biotic environment;
4. interaction of biology and technology with the ethical and human implications;
5. general chemistry I & II with labs (8 semester hours minimum);
6. physics and earth science (4 semester hours each);
7. study of mathematics through the pre-calculus level (college algebra and above) and statistics.

The program uses varied and authentic assessments of candidate's understanding and ability to apply that knowledge. Examples of performance assessments in which this content knowledge could be demonstrated appear in standards 8.21.2 through 8.21.10 which apply to all science education programs.

13020.1 CHEMISTRY

The chemistry program requires study of organic, inorganic, analytical, physical chemistry, and biochemistry. This study includes:

1. systematic and quantitative fundamentals of chemistry;
2. interaction of chemistry and technology and the associated ethical, environmental and human implications;
3. physics, biology, and earth science (minimum of 16 semester hours with at least four semester hours in each discipline);
4. study of mathematics through calculus (minimum of one semester of calculus) and statistics.

The program uses varied and authentic assessments of candidate's understanding and ability to apply that knowledge. Examples of performance assessments in which this content knowledge could be demonstrated appear in standards 8.21.2 through 8.21.10 which apply to all science education programs.

13035.1 EARTH SCIENCE

The earth science program requires study including:

1. the interdisciplinary nature of earth and space science, including lithosphere, atmosphere, hydrosphere, space and their relationships to humans and the

environment;
2. specialization in one of the earth and space sciences: astronomy, geology, meteorology, or oceanography;
3. minimum of eight semester hours in geology (physical geology with lab and historical geology with lab)
4. minimum of one semester each in astronomy and meteorology;
5. the impact of technologies on the lithosphere, atmosphere, and hydrosphere;
6. general chemistry I & II with labs (8 semester hours minimum);
7. physics and biology with labs (4 semester hours each);
8. study of mathematics through pre-calculus (college algebra and above) and statistics.

The program uses varied and authentic assessments of candidate's understanding and ability to apply that knowledge. Examples of performance assessments in which this content knowledge could be demonstrated appear in standards 8.21.2 through 8.21.10 which apply to all science education programs.

13047.1 COMPOSITE SCIENCE MAJOR/GENERAL SCIENCE

The composite/general science program must include environmental science incorporated within other courses or as a separate course. The composite/general science program requires:

1. coursework in biology, chemistry, physics, and earth science, including:
    a. minimum of 24 semester hours in one area,
    b. minimum of 12 semester hours in two other areas,
    c. minimum of 4 semester hours in the fourth area,

    courses must be from those that the institution allows toward graduation in the science major;
2. study of mathematics through the pre-calculus level (college algebra and above) and statistics.

The program uses varied and authentic assessments of candidate's understanding and ability to apply that knowledge. Examples of performance assessments in which this content knowledge could be demonstrated appear in standards 8.21.2 through 8.21.10 which apply to all science education programs.

13045.1 PHYSICAL SCIENCE

The physical science program requires:

1. coursework in chemistry and physics, with labs (minimum 15 semester hours in each discipline);
2. coursework in earth science (minimum 12 semester hours):
3. introductory biology (4 semester hours);
4. laboratory and field experiences in the sciences;
5. study of mathematics through calculus (minimum of one semester of calculus) and statistics.

The program uses varied and authentic assessments of candidate's understanding and ability to apply that knowledge. Examples of performance assessments in which this content knowledge could be demonstrated appear in standards 8.21.2 through 8.21.10 which apply to all science education programs.

13050.1 PHYSICS

The physics program requires:

1. systematic and quantitative study of physics including modern physics, mechanics, electricity & magnetism, thermodynamics, optics, and electronics (minimum 32 semester hours);
2. laws of physics and their application to various areas of physics and modern technology;
3. interaction of physics and technology with the ethical and human implications;
4. chemistry, biology, and earth science (minimum 16 semester hours; at least 4 semester hours in each area);
5. study of mathematics through calculus (minimum 2 semesters) including an introduction to differential equations.

The program uses varied and authentic assessments of candidate's understanding and ability to apply that knowledge. Examples of performance assessments in which this content knowledge could be demonstrated appear in standards 8.21.2 through 8.21.10 which apply to all science education programs.

13010.2, 13020.2, 13035.2, 13045.2, 13047.2, 13050.2 NATURE OF SCIENCE

The program requires study of the history and philosophy of science as well as the interrelationships among the sciences. The program uses varied performance assessments of candidate's understanding and ability to apply that knowledge.

Examples of performance assessments may include how to:

- assist students in understanding that the study of science is a continuous and integrated process of observing, questioning, investigating, and reflecting;
- construct age-appropriate learning activities that assist students' understanding of common scientific concepts such as systems, evidence, models, constancy and change, or form and function;
- engage students in comparing and contrasting scientific and nonscientific ways of knowing; integrating criteria of science in investigations and case studies;
- develop learning experiences for students which demonstrate an interdisciplinary understanding of science;
- develop student understanding of the relationships which exist among science, technology, societal needs, and community issues.

13010.3, 13020.3, 13035.3, 13045.3, 13047.3, 13050.3 INQUIRY

The program requires study of the processes of science common to all scientific fields. The program uses varied performance assessments of candidate's understanding and ability to apply that knowledge. These may include how to:

- locate resources, design and conduct inquiry-based, open-ended investigations, interpret findings, communicate results, and make judgments based on evidence;
- use listening and questioning strategies that encourage inquiry and probe for divergent student responses;
- plan and implement data-based activities requiring students to reflect upon their findings, make inferences, and link new ideas to preexisting knowledge;
- encourage productive peer interactions and plan both individual and small group activities to facilitate inquiry;
- promote student use of scientific process, decision-making, and analysis skills for investigating science-related real-life problems.

13010.4, 13020.4, 13035.4, 13045.4, 13047.4, 13050.4 CONTEXT OF SCIENCE

The program requires the study of the effect of social and technological context on the study of science and on the application and valuing of scientific knowledge. The program prepares candidates to relate science to the daily lives and interests of students and to a larger framework of human endeavor and understanding. The program provides the candidate with an understanding of the relationship of science to industry, business, government, and multicultural aspects of a variety of communities. The program uses varied performance assessments of candidate's understanding and ability to apply that knowledge.

Examples of performance assessments may include how to:

- engage students in activities and projects in which they examine important social or technological issues and implications related their discipline(s);
- analyze how ethics and values affect scientific knowledge and its applications in technology and society;
- relate science to the personal lives and interests of students, to potential careers, and to knowledge in other domains;
- use data relevant a variety of communities, their culture, and their resources to relate science lessons that are appropriate for those communities.

13010.5, 13020.5, 13035.5, 13045.5, 13047.5, 13050.5 SKILLS OF TEACHING

The program requires the candidate to demonstrate proficiency in methods of teaching science. The program uses varied performance assessments of the candidate's understanding and ability to apply that knowledge.

Examples of performance assessments may include the candidates being able to:

- foster competency in the use of scientific processes to investigate phenomena, interpret findings, and communicate results;
- engage all students in the study of science, providing for differences in gender, socioeconomic background, culture, ethnicity, academic ability and disabilities;
- select and use a variety of age-appropriate instructional strategies, materials, and assessment methods for teaching and evaluating student success in science;

- identify goals, objectives and related assessment in science instruction;
- be able to state a philosophy and provide a rationale for choosing particular science teaching strategies.
- identify common student misconceptions or naïve conceptions in the content field, their source, and appropriate teaching responses;
- reinforce the learning and understanding of key concepts from several perspectives;
- apply grade-level appropriate mathematical and computer skills to the scientific investigation of phenomena and the analysis of data.

13010.6, 13020.6, 13035.6, 13045.6, 13047.6, 13050.6 CURRICULUM

The program provides candidates with information necessary to identify, evaluate, and apply a coherent, focused science curriculum that is consistent with state and national standards for science education and appropriate for addressing the needs, abilities and interests of students. The program uses varied performance assessments of candidate's understanding and ability to apply that knowledge.

Examples of performance assessments may include how to:

- relate instructional goals, materials, and actions to state and national science education standards, analyzing strengths and weaknesses in a particular classroom context;
- identify, evaluate and assemble science curriculum and instructional materials from a variety of sources, including the Internet;
- develop and implement long-range and unit plans, with clear rationales, goals, methods, materials and assessments;
- understand the role of technology in education and define a rationale and long-range strategy for including technology in science education;
- design and implement learning activities that thematically relate science with other school subjects and community resources.

13010.7, 13020.7, 13035.7, 13045.7, 13047.7, 13050.7 ASSESSMENT

The program prepares candidates to use a variety of performance assessment strategies to evaluate the intellectual, social, and personal development of the learner in all aspects of science.

Examples of performance assessments may include experience with and knowledge of how to:

- identify and use the most appropriate methods for gathering information about student learning;
- align assessment with instructional objectives;
- demonstrate the ability to use multiple strategies to assess teaching and learning authentically, consistent with national standards and goals for science education;
- engage in reflective self-assessment and develop a system for self-assessment as a practicing teacher.

13010.8, 13020.8, 13035.8, 13045.8, 13047.8, 13050.8
ENVIRONMENT FOR LEARNING

The program prepares candidates to design and manage safe and supportive learning environments in the classroom, laboratory, and field. The program reflects high expectations for the success of all students. The program uses varied performance assessments of candidate's understanding and ability to apply that knowledge.

Examples of performance assessments may include how to:

- maintain a positive classroom environment conducive to the learning of science;
- identify and promote the elements of an engaging and stimulating science learning environment;
- plan and develop opportunities for students to investigate and learn from resources, artifacts, exhibits, events, displays and the environment;
- structure age-appropriate laboratory and field experiences for students;
- help students understand the appropriate use of scientific equipment and materials;
- set up procedures for safe handling, labeling and storage of chemicals, electrical equipment, and other materials and know actions to take to prevent or report an emergency;
- demonstrate knowledge of legal responsibilities and know how to act to prevent potential problems with liability and negligence, especially as applied to science teaching;
- practice the safe and ethical use and care of animals for science instruction within the standards and recommendations of the science community and applicable regulations.

13010.9, 13020.9, 13035.9, 13045.9, 13047.9, 13050.9 PROFESSIONAL PRACTICE

The program prepares candidates to participate in the professional community, improving practice through their personal actions, education, and development. The program uses varied performance assessments of candidate's understanding and ability to apply that knowledge.

Examples of performance assessments may include:

- developing and stating personal goals and a philosophy of teaching based on research and contemporary values of the science education community;
- demonstrating understanding of the concept of a community of learners and interacting with instructors and peers as a member of such a community;
- documenting and reflecting upon personal strengths and weaknesses in an effort to improve their preparation to teach science;
- taking personal responsibility for growth and assisting others who are preparing to teach science;
- demonstrating the ability to handle problems and tension calmly and effectively, and relating to students, peers, instructors, and supervisors with integrity;
- participating in professional associations and activities and reading professional journals in an effort to improve teaching and stay abreast of current events and needs in the field.

13010.10, 13020.10, 13035.10, 13045.10, 13047.10, 13050.10 TECHNOLOGY

The program requires the study of current, appropriate instructional technologies. The program uses varied performance assessments of candidates' understanding and abilities to apply that knowledge.

Examples of performance assessments may include how to:

- demonstrate appropriate use of various technologies within their teaching;
- select and use appropriate technology tools specific to their content area(s);
- use technology to effectively manage communications, instructional planning, record keeping and data management;
- use instructional technologies, including computers, interactive video, telecommunications, and other new technologies to promote use of scientific processes and problem-solving skills.

History

Revised August 12, 2005, mandatory for visits July 1, 2006.
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